ADEQ
Arizona Department
of Environmental Quality

POLLUTION PREVENTION (P2) ANALYSIS AND PLAN GUIDANCE MANUAL

Arizona Department of Environmental Quality
Sustainability Programs Unit
Pollution Prevention Program
1110 West Washington Street
Phoenix, Arizona 85007

Disclaimer

The manual is neither rule nor law. It does not replace the Arizona Revised Statutes (A.R.S) §49.961 - §49.973 but is written to assist in developing a pollution prevention plan.

Please consider the environment before printing this document.

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Introduction

In 1990 the Arizona legislature adopted a state Pollution Prevention (P2) Policy that states: "In the interest of protecting the public health and safety and the environment, the legislature declares that it is the policy of this state to:

1) Encourage pollution prevention whenever technically and economically practicable, without shifting risks from one part of the process, environmental medium or product to another.
2) Reduce the amount of hazardous substances used and reduce the amount of hazardous waste generated in this state."

Waste Management Hierarchy

The national waste management hierarchy provides the guiding principles for P2 efforts. Source reduction is the most desirable option, followed by recycling, energy recovery and treatment. Disposal is the last resort if the waste cannot be prevented or recycled.

Figure 1

In Arizona, Pollution Prevention (P2) means:

"operational procedures and processes and improvements in housekeeping or management techniques that reduce potential or actual releases of pollutants to the overall environment including all air, water and land resources affected by those pollutants".

P2 includes any of the following:

- Source reduction
- Toxics use reduction
- Recycling
- Waste minimization
- Reuse
- Reclamation
- Conservation
- Substitution
- Changes in operating practices
- Spill and leak prevention
- Inventory control

This manual is provided to assist facilities as they prepare P2 analysis and submit P2 Plans (Plans) or amendments.

Plan forms are available for download at:

http://azdeq.gov/function/forms/appswaste.html#p2

ADEQ P2 staff is available to provide assistance during the development of a plan, amendment or annual progress report. Feel free to call or contact any P2 staff member:

Jeanine Inman - ji1@azdeq.gov or 602-771-2351
Linneth Lopez - lal@azdeq.gov or 602-771-4739

General information about ADEQ's P2 Program is available at:

http://azdeq.gov/environ/waste/p2/index.html

Part 1

- **Pollution Prevention (P2) is a Sensible Approach for Businesses**
- **Three Myths about P2 Demystified**
- **How to Create A Successful P2 Program**
- **How to Use This Guidance Document**

Pollution Prevention (P2) is a Sensible Approach for Businesses

WHAT IS POLLUTION?

Pollution is waste. Materials that are sent to the landfill, discharged into drains or emitted from stacks are wasted. The raw materials, labor and energy inputs to create a product were bought at a cost and preventing waste can be a sensible approach for businesses.

WHAT IS P2?

P2 involves identifying the decisions that result in emissions, waste generation or toxic substance use and determining if those decisions can be changed to minimize or eliminate the pollution. Identifying preventative waste measures can result in cost savings. P2 is an essential component of many environmental management concepts; for example:

Waste minimization is a subset of P2. It is the reduction to the extent feasible, in the total volume, quantity, or the reduction of toxicity of the hazardous waste.

Sustainable development involves economic, social and environmental issues. The most often quoted definition of sustainable development which is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" was defined in the 1987 Brundtland Commission's report and supports the concept of P2.

Industrial ecology focuses on shifting industrial processes to closed loop processes where waste can become raw materials/inputs for new processes. P2 is an important component of industrial ecology.

Cleaner production is a preventative environmental strategy intended to minimize waste and reduce risks to humans and the environment.

Environmental Management System (EMS) is a systematic way to review and improve operations for better environmental performance. P2 is an essential component of an EMS.

Three Myths about P2 Demystified

1) **Large or small businesses cannot afford P2.**

   In many cases businesses actually save money by implementing P2 activities. For example, if facilities can find ways to reduce their waste or toxic substances, they can reduce waste disposal costs and long term liability. Simple measures like spill and leak prevention can result in cost savings with little capital input. Facility management can implement a P2 program that focuses on continuous improvement to ensure the long term viability of the program.

2) **It is very time consuming to find ways to reduce pollution.**
   A basic analysis of a facility's processes and how wastes are generated can lead to opportunities to reduce pollution. Usually employees who are involved in the processes can offer suggestions on how to reduce pollution. Sometimes a basic facility walk-through or even a simple flow chart showing process inputs and outputs can help a facility identify opportunities for P2.

3) **Assistance for P2 is not readily available.**
   ADEQ P2 staff members are available to provide regulatory assistance. Refer to contact information provided in the Introduction on page 2 for contact details. This guidance manual is a useful tool and should be reviewed before completing a P2 Plan. The EPA's "An Organizational Guide to Pollution Prevention" can be downloaded at: http://www.epa.gov/oppt/ppic/pubs/organizationalGuide.pdf

Implementing a P2 program can have many benefits including:

- Reduced costs of waste treatment and disposal, raw materials purchases, and process operations
- More efficient use of raw materials, staff resources, equipment, energy and water
- Meeting or exceeding environmental requirements
- Reduced potential environmental liabilities
- Protection of employee health and safety and the environment
- Improved company's relationship with the public, neighbors and customers

How to Create A Successful P2 Program

Many companies understand the simple importance of P2 and have moved away from a pure compliance philosophy. They have learned that public expectations for a clean and safe environment are a better gauge to drive their environmental programs - not minimum compliance with regulations. Businesses are establishing environmental principles designed to govern company-wide decision-making and to ensure they are moving well beyond minimum standards set by regulations.

Facilities have implemented a variety of P2 programs in Arizona. The following elements are considered important to the most successful P2 programs.

1) **Management support of P2**. Facilities with strong management commitment are more successful with P2. Management can ensure:

- P2 is integrated into business planning
- Resources are allocated for P2 implementation

- Environmental considerations are part of business planning processes
- Facility P2 goals are part of the business planning process
- P2 is used, whenever possible, in anticipation of future compliance
- requirements
- A formal P2 focused environmental policy is developed

2) **Use of a champion, facilitator or focal point person to lead the program**. A point person is one who understands the importance of P2 and helps to motivate others to commit to P2.

3) **Implementation of cross-functional P2 team or 'green team.'** The purpose of forming a P2 team is to utilize the diverse skills of the team members to develop innovative P2 activities. A P2 team can help ensure:

- Employees from various work areas, departments are involved
- Employees understand the importance of P2
- The facility defines specific P2 objectives
- Goals are developed from potential opportunities
- Projects are reviewed and tracked
- Successes are communicated to employees to promote P2

4) **Identification of waste streams, emissions and toxic substance use**. Use employee participation and train employees in P2 to help in this effort. Also, recognize employees for valuable P2 contributions. Some facilities have corporate level recognition programs that help sustain employee motivation.

5) **Understanding why waste streams, emissions and toxic substance use occurs**. Root cause analysis can be conducted for each waste. Root-cause analysis is the systematic process of identifying all of the internal causes that have generated, contributed to, or allowed the pollution. This can be helpful to define goals. Facilities can also discover underlying causes for emissions, waste and chemical use by continually asking the 'five whys'. Alternatively, use of analysis techniques such as cause and effect diagrams and process mapping or quality tools (i.e. team based quality culture, ISO 9000/14000, Pareto principles or total quality management) can help identify the cause of the waste or toxic substance.

6) **Selection of P2 opportunities that are technically and economically favorable**. Once an analysis of various processes has occurred, a facility can work with employees, raw material suppliers, customers and vendors to determine which opportunities are feasible. Research can be conducted to determine if P2 can be incorporated into the development and design phases of the product or process life.

7) **Development of goals and establishing completion dates**. This element is important as goals are defined for a specific P2 effort. Use baseline quantities as a reference and determine realistic reduction goals. Completion dates should be defined for each goal and there should be a clear understanding of what actions will be taken to implement the goals.

8) **Implementation of a tracking process.** Some facilities track weekly or monthly reductions and then compare to baselines to determine success. If cost measures can be

associated with the reductions, these results should be communicated to employees involved in the P2 efforts.

9) **Recognition of accomplishments and re-evaluation of program.** Immediate recognition of early accomplishments helps establish the P2 program and can drive employee motivation. Some facilities have local or corporate level recognition programs. The program should be evaluated for improvements and new P2 opportunities.

How to Use This Guidance Document

1) Download Plan forms at http://azdeq.gov/function/forms/appswaste.html#p2
2) Review information in Part 1 of this manual
3) Complete the forms using the example Plan in Part 2 as a guide.
4) Refer to Part 4 provides information on P2 tools for analyzing your materials or processes and finding the root cause of a waste or emission

Many P2 analysis tools are the same tools used in the development of an Environmental Management System (EMS). In particular the identification of **environmental aspects** and **environmental impacts** can help with P2 and EMS.

An environmental aspect is any element of a facility's activities, processes, wastes, products, or services that can interact with the environment. An activity, process, waste product or service does not have to be regulated to be considered an aspect.

Not all environmental aspects cause environmental impacts. Environmental aspects can include air emissions, hazardous waste, metals, solid waste, water or energy.

An environmental impact is any change to the environment due to a facility's activities, processes, wastes, products, or services. These changes can be positive or negative.

An EMS is beneficial for a company that does not have a comprehensive management program and some facilities use goals developed in their EMS program for their P2 Plan.

Part 2

- **What is a Pollution Prevention Plan**
- **Developing the P2 Analysis**
- **Example Plan**
  Note: Blank Plan forms can be downloaded at
  http://www.azdeq.gov/function/forms/appswaste.html#p2

What is a Pollution Prevention Plan?

The Pollution Prevention (P2) statutes established in Arizona empower facilities to use knowledge of their own processes and procedures to reduce the use of toxic substances at the source, minimize the generation of hazardous waste, and prevent the release of pollutants to the environment.

A P2 Plan (Plan) is a stand alone management document that provides information on the facility operations that directly or indirectly produce waste or use toxic substances. The written Plan will analyze the current work practices, outline potential P2 opportunities and provide specific performance goals including a schedule for implementing these P2 activities. The Plan should also describe performance measures, which allow measurement or evaluation of the P2 goals completed.

The Plan will document that the facility has performed a rigorous P2 assessment. In addition to describing current practices and planned pollution prevention activities, it will include information on past pollution prevention activities that have already been completed at the facility.

Developing the P2 Analysis

The P2 Analysis (Section 6 of ADEQ Plan forms) is one of the core parts of the Plan. Refer to Part 1 – page 6 on how to create a successful P2 program for a general overview and the example Plan (page 13) for more details. The Plan analysis should include the processes that use or result in the generation of toxic substances and wastes for which the facility meets the filing thresholds. P2 teams created using employees in various areas of your operation (maintenance, operations, accounting, warehousing, etc) can help in the analysis process. Some teams have only two members while others can have eight or more.

In the Plan you should discuss:

- Each of the toxic substances that the facility used in excess of 10,000 pounds in the preceding calendar year
- Each toxic substance for which the facility has filed a federal Toxic Release Inventory (TRI) form for the preceding calendar year
- All acute hazardous waste and hazardous waste generated or shipped offsite for purposes other than recycling above the filing thresholds during the preceding calendar year. The acute hazardous waste threshold is an average of one kilogram per month and the hazardous waste filing threshold is 1,000 kilograms per month.

The analysis for each process should include:

- Why the toxic substances and hazardous wastes are used
- The wastes and emissions generated by the process
- The root cause of each waste generation, emission or toxic substance

Choose a reasonable amount of systems, processes or areas to analyze. Then develop a process description, root cause analysis and opportunities section for each one, even if the analysis results in having no current opportunities or if none of the listed opportunities will be implemented during the Plan time frame. These non-implemented opportunities may become goals in the future amendments to the Plan as they become feasible. It is not expected that goals will be developed and acted upon immediately for all chemicals and all wastes. This can be accomplished over time using Plan amendments to add new reduction goals. ADEQ understands that P2 is a process of continual improvement. Sometimes only certain process level projects can be implemented because the number of reduction actions depends on the facility size, resources, technical feasible, economic feasibility and strength of commitment.

A facility can include wastes and chemicals below the filing thresholds, energy efficiency upgrades (which reduce pollution), water conservation efforts (which help our state) and solid waste reduction efforts.

P2 tools (fishbone diagrams, process maps, etc.), can be used to determine possible reduction methods and opportunities. After further research and discussion, the best solutions are put into action as reduction goals (Section 7 of ADEQ forms).

An example plan is provided to assist with completing the plan forms. Also, Part 4 of this manual discusses some of the P2 analysis tools that can be used to develop P2 goals.

(Example Plan)

Pollution Prevention (P2) Analysis and Plan for

ABC Incorporated

(Company Name)

ADEQ P2 ID Number: 20*0999*

This document is an:

☒ **Original Plan**

☐ **Amendment to the Original Plan**

The Plan Time Frame (Section 5) is:

From: *June 1, 2013* **(beginning date)**

To: *July 1, 2015* **(the last goal completion date)**

Mail the completed P2 Plan to:

Arizona Department of Environmental Quality
Sustainability Programs Unit
Pollution Prevention Program
1110 West Washington Street
Phoenix, AZ 85007

Section 1. General Information (A.R.S §49-963.J.1 and J.2)
Requirement: Provide the name and location of the principal business activities at the facility, and the name address and telephone number of the owner or operator of the facility and of the senior official with management responsibility at the facility

Name of Company: ABC Incorporated

Owner or Operator Name and Telephone Number: Rodney Senior, 602-555-1123

Mailing Address: P.O. Box 123, Phoenix, Arizona 88888

Description of what this business does (principal business activity): Manufactures cultured marble bathroom fixtures such as sink tops, bathtubs, and showers. Our state of the art production facility in Phoenix is able to offer a wide selection of color and design options.

P2 Technical Contact Information:

Contact Person: John Doe

Telephone Number: 602-555-1122 Fax Number: 602-555-1135

E-mail Address: john.doe@abcinc.com

*One P2 Plan may be submitted to cover more than one facility. Please ensure that Section 3 is completed for **each** facility covered by this Plan.*

How many facilities will be covered by this Plan? 1

Section 2. Certification (A.R.S. §49-963.J.2 and 3)

I certify that I have personally examined this Pollution Prevention Plan. I am familiar with its contents and all attachments. Based on my inquiry of the persons immediately responsible for obtaining the information contained in the Plan, I believe, to the best of my knowledge, the information presented in the Plan is true, accurate and complete.

Certifying Signature	Title	Date
	President & CEO	6/5/2013

For the person certifying the Plan: (This person must be a senior official with management responsibility at the facility.)

Print Name: Sid D. Senior

Print Title: President & CEO

Telephone Number: 602-555-1345 ***Fax Number:*** 602-555-1135

E-mail address: sid.senior@abcinc.com

Guidance for Section 1: General Information

Name of Company:
Enter the name of the company, the owner or operators name and telephone number.

Mailing Address:
Enter the mailing address of the company where the contact person can be reached during normal business hours and where ADEQ will mail information.

Description of what this business does (principal business activity): Provide a detailed description of the principal business activity and processes at the facility. You should consider adding information from the facility's corporate web page as it may describe in good detail what the company does and what products it manufactures.

P2 Technical Contact Information:

Contact Person:
Enter the name of the P2 contact person. This should be the person at the facility who can be contacted by ADEQ for questions about the development and implementation of the Plan.

Telephone Number, Fax Number, E-mail Address:
Enter the work phone, fax and e-mail of the contact person.

How many facilities will be covered by this plan?
Enter the number of facilities at different locations that are covered by this Plan.

Guidance for Section 2: Certification

Certification Statement:

Have the senior official with management responsibility at the facility review the Plan and sign the Plan certification statement.

- Print or type the official's name, the date the certification was signed, the official's title, telephone number, e-mail, and fax number in the appropriate locations.

- The person certifying the Plan should have the authority to assure that resources are allocated to implement the Plan to achieve the Plan goals.

Section 3. Facility Information (A.R.S. §49-963-J.1; §49-963-I)

Facility Name: ABC Incorporated

Physical Address: 1234 Main Street, Phoenix, AZ 88888

Primary NAICS Code (6 digits): 326199 **Other NAICS Codes** (optional): None

Permits: *Please list below any permits at this facility. Write "NONE" for any permits that do not apply.*

RCRA ID Number (also known as EPA ID Number): AZD111222333

NPDES Permits: ADEQ permit AZR00A212

Air Quality Permits: Maricopa County Permit A9600202

Water Quality Permits: None

Other: List any other environmental permits: None

Plan Requirement Threshold(s) Met
(Please check all Plan filing threshold(s) the facility met which requires this facility to file and maintain a P2 Plan.

☐ Generated or shipped offsite for purposes other than recycling an average of one thousand kilograms per month of hazardous waste in calendar year 20_____. *The cumulative amount and streams of hazardous waste generated at the facility include all of the following waste streams:*_____

☐ Generated or shipped offsite for purposes other than recycling an average of one kilogram per month of acutely hazardous waste in calendar year 20_____. *The cumulative amount and streams of acutely hazardous waste generated at the facility include all of the following waste streams:*_____

☒ Met the thresholds required to file a Toxic Release Inventory (TRI) form (form R or A) for the calendar year 2012. The TRI identification number assigned to this facility is *85993CBLSC7211N.The TRI chemicals that met the thresholds are: Styrene*

☒ Used in excess of 10,000 pounds of a toxic substance in calendar year 2012. The *toxic substances used above the 10,000-pound threshold* are: *Styrene*

☐ Facility wants to file a voluntary P2 Plan although it does not meet the P2 Plan filing thresholds.

Guidance for Section 3: Facility Information

If there is more than one facility covered by this Plan, complete one Section 3 form for each individual facility included in the Plan.

Facility Name:

Enter the facility name.

Physical Address:

Enter the complete physical street (location) address of the facility.

Description of Principal Business Activity:

Explain in a detail what the facility at this location does. This is often what products the facility manufactures and who uses those products. Be as specific as possible. Do not give the North American Industry Classification System (NAICS) code description as the description.

Primary NAICS Code:

Provide the facility six digit primary North American Industry Classification System (NAICS) code number. For assistance, refer to the U.S. Census Bureau's website at: http://www.census.gov/eos/www/naics/

Other NAICS codes (optional)**:**

List any additional NAICS codes that the facility operates under.

Permits:

Give the name and identification number of any federal, state, county or municipal environmental permits applicable to the facility.

Plan Requirement Threshold(s):

There are several plan filing thresholds and any one, if met, can require a facility to file a Plan. Put a check mark in the box next to each threshold met by this facility. Fill in the year that each threshold was met.

If no threshold has been met and the facility desires to file a Plan voluntarily, then place a check in the box next to voluntary Plan filer.

Section 4. Management and Corporate Support (A.R.S. §49-963.J.5 and J.9)
Requirement: Provide a written policy setting forth management and corporate support for the pollution prevention plan and a commitment to implement the Plan to achieve the plan goals. The Plan shall include employee awareness and training programs to involve employees in pollution prevention planning and implementation to the maximum extent feasible.

P2 POLICY

Check box 1 or 2 below.

1. ☒ The senior official with management responsibility at the facility has signed, and we have posted in our facility, a copy of the P2 Policy contained in the ADEQ P2 guidance manual. A copy of the signed policy is provided on the next page of this Plan.

OR

2. ☐ The senior official with management responsibility at the facility, has signed, and we have posted in our facility, a copy of our own P2 Policy setting forth management and corporate support for the P2 Plan and a commitment to implement the Plan to achieve the Plan goals. A copy of the signed policy is provided on the next page of this Plan.

Check each box that applies and complete information below that applies.

3. ☒ The policy will be displayed in view of all employees and introduced to new employees

   The policy is posted at the following location(s): Employee Break Area

4. ☒ The policy will be available in languages other than English, as appropriate, and to the public and customers (as appropriate). Spanish

Pollution Prevention (P2) Policy

Name: ABC Incorporated

Our company is committed to protecting the health and safety of the public, our employees and protecting the environment.

To the best of our ability we will:

- Develop a P2 Plan and implement the Plan to achieve the Plan goals.
- Provide employee awareness and training programs to involve employees in P2 planning and implementation to the maximum extent feasible.
- Incorporate the P2 Plan into management practices and procedures.
- Use P2 to reduce or eliminate the toxicity and the amount of toxic substances and hazardous wastes and minimize their undesirable effects on air, water and land resources, and to conserve resources, including energy and water.
- Comply with the relevant laws and regulations and implement programs and procedures to assure environmental compliance.

Our management and employees are committed to continual improvement and will continuously seek opportunities to improve the effectiveness of our environmental program.

Signature	Title	Date
	Vice President	June 6, 2013

Guidance for Section 4:
Management and Corporate Support

The P2 Policy is the rallying point for the P2 program and is very important for its successful implementation.

Check box 1 or 2 shown in this section.

If you check box 1, have the enclosed P2 Policy signed and then posted in your facility.

If you check box 2, please include a copy of your facility's own P2 Policy.

Check box 3 to confirm the policy has been posted and list or describe all of the places that the policy is posted.

There is no specific requirement where to post the policy, but it should be where all the employees can read it. If you want visitors to your facility to see that you have a P2 Policy, consider posting it in your visitor lobby, waiting or reception area.

Check box 4 to confirm the policy has been posted in languages that your employees can understand.

Most importantly, include or attach a copy of that policy to the Plan or amendment submitted to ADEQ.

The environmental policy must include these statements from A.R.S. §49–963.J.5:

- Management supports the development of the P2 Plan
- Management is committed to implement the plan to achieve the Plan goals

Management should consider including additional statements such as:

- Management encourages and supports employee participation in the P2 Program (A.R.S. §49–963.J.9)
- Compliance with regulations: We will comply with all relevant laws and regulations and will implement programs and procedures to assure compliance (from Environmental Management System requirement).
- Continual improvement: We are committed to continual improvement and will continuously seek opportunities to improve the effectiveness of our environmental program (from Environmental Management System requirement).
- Other important statements about your facility's environmental commitments

Section 5. Scope and Objectives (A.R.S. §49-963.K; A.R.S. §49-963.J.6)
Requirement: The time frame of the original Plan must span at least 2 years at a minimum. Provide a statement of the Plan's scope and objectives.

Plan Time Frame: The current time frame of this Plan or amendment will be:

FROM: 6/01/2013 **TO THE LAST GOAL COMPLETION DATE**: 7/01/2015
(month/day/year) (month/day/year)

Note: Plan time frame must be the same as the date defined on the cover page.

PLAN SCOPE

The Plan scope should contain, at a minimum, a list of all process areas to be analyzed in the Section 6 process review, and include toxic substances and hazardous wastes for which the facility must file this Plan. This scope should be as specific as possible, as an example, you may use a facility wide process area such as "Spill and Leak Prevention" or a process area such as a "Spray Booth Operations." Note each process area listed here must have a corresponding "Analysis and Opportunity Development" completed for Section 6.

Staff will look at the following process areas for this Plan:

1. Spray Booth Operations/Gel coating
2. Material Receiving Area
3. Spill and leak prevention
4. Finishing

ENVIRONMENTAL OBJECTIVES
The general scope objectives were developed and include the following *(Check all that apply*):

- ☒ Improved operating practices to improve housekeeping, or spill and leak prevention.
- ☐ Improved management practices, such as purchase and inventory control.
- ☒ Process or equipment modifications to minimize the use of toxic substances.
- ☐ Process or equipment modifications to minimize the generation of hazardous waste.
- ☐ Process or equipment modifications to minimize the generation of hazardous air pollutants (HAPs) or volatile organic compounds (VOCs) or particulate emission reductions.
- ☒ Raw material modifications or substitutions to minimize the "use" of toxic substances.
- ☐ Resource conservation (water, energy, etc).
- ☐ Reuse or recycling of materials or wastes.
- ☐ Reduction in use or emissions of greenhouse gases or ozone producing chemicals
- ☒ Other: Protecting employee safety and health

Guidance for Section 5: Scope and Objectives

Plan Time Frame:
The starting date should be near the submittal date of this Plan. The completion date should be the last goal completion date from the goal sheets in Section 7. The completion date is also the expiration date, after which a Plan amendment is needed to continue the Plan until Plan filing thresholds are no longer met. The Plan time frame must be the same as the date defined on the cover page.

When you develop the Plan for the first time, the time frame must span two years. It may span more than two years per A.R.S. §49–963(K) at the discretion of the facility.

After the original Plan expires, you must submit a Plan amendment to maintain and continue the Plan. ADEQ recommends an amendment time frame of at least two years.

Plan Scope:
The scope of the report is defined by determining the factors which you will study. For the scope you may want to focus on a particular area of the facility. By area, we mean the Plan will study reductions in either an area of the facility which contains various processes or in specific processes, procedures, chemicals, wastes, or emissions, whichever is most practical and logical for your facility.

Briefly list what process areas the management and staff will focus on for the development of this Plan. This scope should be as specific as possible, as an example, you may use a facility wide process area such as *"Spill Leak and Prevention"* or a process area such as a '*Material Receiving Area."* Note each process area listed here must have a corresponding "Analysis and Opportunity Development" completed for Section 6. Please note only one process area - 1. Spray Booth Operations/Gel Coating is analyzed in the Section 6 example provided.

Environmental Objectives:
Put a check mark in the box(es) corresponding to any objectives that have been identified for this Plan time frame. These objectives will further guide your process review, opportunity identification and goal development

Section 6. Analysis and Opportunity Development (A.R.S. §49–963.J.7)
Requirement: Provide an analysis identifying pollution prevention opportunities to reduce or eliminate toxic substance releases and hazardous waste generation.

1. Process Area (# 1): Spray Booth Operations/Gel Coating Process

2. Process Information

a. ☒ Describe the process steps:

1) Completed cultured marble pieces (sinks, tubs and shower stalls) are moved on rolling tables to a filtered open front spray booth.
2) Gel coat is mixed inside the spray gun with 2% methyl ethyl ketone peroxide (MEKP) and gel coat resin containing about 49% (weight percent) styrene monomer resin.
3) Styrene gel coat resin and MEKP is applied in the spray booth with a high volume low pressure (HVLP) spray gun so that a layer of gel coat is applied onto the cultured marble piece.
4) The cultured marble piece is then placed into one of the two natural gas heated curing tunnels to dry. The curing tunnels. The curing tunnels have a series of thick plastic strips on one side so employees can reach in and move the sprayed pieces in and out of the tunnel. Exhaust from the tunnels is vented to the outside.

b. ☒ Discuss the toxic substances (inputs) used in the process and why they are used:

Methyl ethyl ketone peroxide (MEKP) and gel coat resin containing styrene monomer resin is used to provide a protective coating on the pieces. This MEKP catalyst assists in curing the resin coating.

c. ☒ Discuss the wastes and emissions (output) generated by the process. Include wastes and emissions due to spills, cleaning, maintenance, unused or expired raw materials, etc, and include waste codes.

Waste:
Waste includes used spray booth and personal respirator filters, used rags, chemical bottles, drums and totes.

Rags are used for general shop cleanup, which is necessary due to gel coat over spray. Used spray booth and respirator filters as well as used rags are placed in the trash as solid waste, which is hauled to the local landfill. Empty 55-gallon drums that were emptied of gel coat and acetone are returned to the supplier for reuse.

Gel coat over spray falls on the floor and polymerizes. The floor has a felt covering. This polymerized material and the floor felt covering, which is periodically removed, is sent to the landfill as solid waste.

Any leftover gel coat resin not used is polymerized on-site then sent to the landfill as solid waste.

Emissions:
Emissions are generated from spraying, curing and cleanup. Gel coat spraying and curing creates styrene emissions. Spraying emissions are due to styrene atomization. Curing emissions are from the large surface area of the pieces and volatile nature of styrene, emissions from over-spray on the floor. Some large catalyzed gel coat resin particles containing styrene miss landing on the piece end up on the shop floor or are captured in the spray booth filter, which while curing creates emissions. The MEKP catalyst in the spray becomes incorporated into the product so the MEKP emissions are small.

The spray booth exhaust fan pulls in air, styrene and small MEKP emissions from the gel coat mixture. These emissions are removed from the facility and exhausted directly to the outside by air handling equipment. Facility wide styrene emissions total 2,500 pounds per year. Spray gun equipment is cleaned at the end of each day by spraying a few ounces of acetone through the gun. Acetone is used because it dissolves the styrene resin, which will clog the guns, if it is allowed to cure in the gun. The acetone sprayed through the gun all evaporates as air emissions.

d. ☒ Describe what happens to each waste and emission. (Is it disposed, segregated recycled, treated, incinerated, released to air, etc?): *See answer provided above.*

e. ☒ Discuss whether raw material purchases produce packaging material that must be handled. (i.e. pallets, drums, bags, etc.) If so, describe what happens to this material.

Acetone drums are returned to the vendor for reuse. Gel coat resin totes are returned to the vendor for reuse. MEKP plastic bottles are reused on-site or cleaned and sent off-site as solid waste. There is no other packaging material. Therefore, raw material purchases do not produce much packaging waste.

f. ☒ Discuss the root cause of each waste generation, emission or toxic substance use:

Root Cause
From our process mapping and cause and effect diagrams we know that the styrene emissions result from curing of the gel coat (evaporation) and from our choice of applying the gel coat by atomization (spraying).

Our root cause analysis and further research determined that the air emission amount is affected by: 1) the weight percent of styrene in the gel coat, 2) the application method, 3) the spray gun type, 4) the spray gun applicator's spraying skills (with affects the amount sprayed and the amount of over spray), and 5) the spray pump pressure, spay nozzle choice and equipment setup methods.

Currently there is no other non-styrene substitute that is less toxic or can perform the function for the gel coat resin. However, there are some gel coat resins containing different styrene amounts, and different spray gun types.

The acetone emissions result from choosing acetone as a cleaning solvent and spraying acetone through the spray gun to clean it.

Guidance for Section 6: Analysis and Opportunity Development

Process Review Your facility may consist of a number of operations such as material preparation, casting, gel coating, and finishing. We call these distinct operations "process areas".

1. Process Area
Enter a number and a name for the process area that corresponds to a process area listed in Section 5 under Plan Scope. This is for identification purposes. The numbers should be carried throughout Sections 6 and 7.

2. Process Information
Only describe each current process area, as it was at the beginning of this Plan time frame. Give as much detail as possible so it is understandable.

In every process there is a functional sequence of work steps. You may use process mapping to visualize these steps and share this information with other team members and management.

Besides process mapping, you can use cause and effect diagrams or other company methods to develop other information for the analysis and to ensure all process steps are identified. You should also walk through the entire process and respective plant area at your facility and talk with process operators. You do not need to submit these process maps or cause and effect diagrams, but you may do so. After information is gathered, begin writing the process information into the Plan and while doing so, check the process questions to ensure that all steps are included.

This example Plan will review the cultured marble gel coating process, which is step 3 shown in the overall cultured marble process in Figure 2 on page 28. The gel coating process mapping example is then further developed as shown in the gel coat process steps 3.1-3.4, and the cause and effect example diagram is shown in Figure 3 on page 29. Figures 2 and 3 help to organize and share process information with others.

Process mapping is a powerful tool for tracking all material use and waste production in a process. Part 4 of this guidance manual provides some information on how to develop process maps.

Process Review Questions

To assure that you have completed the P2 analysis, check the corresponding process information boxes on the Plan form as you answer that question in your review. The example only covers one process area, but your Plan will most likely have several process areas.

a. ☒ Describe the process steps.

Describe the functional sequence of work steps for the process. Only describe the current process. Give as much detail as possible about why steps are performed, when they are performed, and how they are performed. The purpose of this is to allow you to get a complete understanding of what happens in your facility and why and how it happens. You should walk through the process area and talk to process operators to ensure that all steps are included.

b. ☒ Discuss the toxic substances (inputs) used in the process and why they are used.

Include the name of each toxic chemical used in the process. Include the auxiliary processes such as cleaning and maintenance of equipment. Be sure to look at all chemicals involved with the process, i.e., solvents and wetting agents. Include those used for maintenance and cleaning activities.

c. ☒ Discuss the wastes and emissions (output) generated by the process. Include wastes and emissions due to cleaning, maintenance, unused or expired raw materials, waste codes, etc.)

Discuss the wastes and emissions that result from this process. You may wish to include solid waste, electricity and water use. Give the specific chemical name such as acetone instead of a generic chemical class name like *solvent* or *F006 Waste*.

Be sure to consider the following sources of wastes, emissions:

- Cleaning and maintenance items such as solvents and their emissions, contaminated lubricating oil, etc.
- Raw material waste. Few processes are 100% efficient
- Expired and unopened materials. These can make up a large part of the waste.

Look back over any notes you have from the facility walk-through to be sure that all substances have been addressed.

Most of the wastes and emissions information can be compiled from reports that have already been compiled such as your facility's Toxic Release Inventory (TRI) Forms, Facility Annual Report (FAR), Air and Water Permits, Hazardous Waste Manifests, spill reports and shipping documents. Some other information, such as losses due to fugitive emissions or leaks, may take more effort to find. A material balance, process step method or some other calculations may be required. To determine what causes the wastes and emissions, you may want to use the cause and effect diagram tool which is described in Part 4.

d. ☒ Describe what happens to each waste and emission. (Is it disposed, segregated, recycled, treated, incinerated, released to air, etc.?)

How is each waste handled while at your facility? Is it stored in drums and tanks or sent to the facility wastewater treatment area? Is the waste segregated? Segregation can significantly reduce a facility's hazardous waste. Some possible ways to segregate wastes are hazardous versus (vs.) non-hazardous waste, recyclable vs. non-recyclable material, chlorinated vs. non-chlorinated solvents, oil vs. solvents, etc.

Discuss each wastes final management method, such as disposed, recycled, reused, treated on-site, etc. for each waste and emission. Could it be handled more efficiently with less environmental impact?

e. ☒ Discuss whether raw material purchases produce packaging material that must be handled (i.e. pallets, drums, bags, etc. If so, describe what happens to this material.

Packaging waste, while usually non-hazardous, hazardous can be a significant portion of a facility's waste stream. Waste can be reduced or eliminated by getting your suppliers to use less packaging, ship in bulk or even take the packaging back for reuse. If reduction does not work, look into recycling. Many packaging materials are recyclable.

f. ☒ Discuss the root cause of each waste generation, emission or toxic substance use.

Root cause is the basic reason(s) that a resource is being used or a waste or emission is occurring. If this cause(s) can be eliminated, the resource use or loss would be prevented. Techniques such as:

- An input-output diagram (Figure 2- page 28)
- A cause and effect diagram tool (Figure 3- page 29) or
- The five whys technique

are effective tools for conducting root cause analysis. Development of these P2 tools is discussed further in Part 4.

To determine the root causes of the wastes and emissions, you may want to consider also:

Process equipment use: Old equipment may cost more then it is worth due to frequent breakdowns, poor product quality, and risk of worker exposure. Sometimes replacing or reconfiguring equipment can have a significant benefit.

Process equipment cleaning and maintenance: Are wastes or emissions generated during cleaning and maintenance of equipment used in this process? Cleaning and maintaining process equipment can produce significant wastes and emissions. Do not forget to include these auxiliary processes in the review.

Chemical use procedures: Do you have procedures in place to review new substances for hazards and regulatory obligations before purchase? By reviewing new chemicals before purchase you can prevent the costs associated with handling hazardous materials and wastes while at the same time reduce liability, decreasing worker exposure and protecting the environment.

Figure 2: Example Cultured Marble Process Map

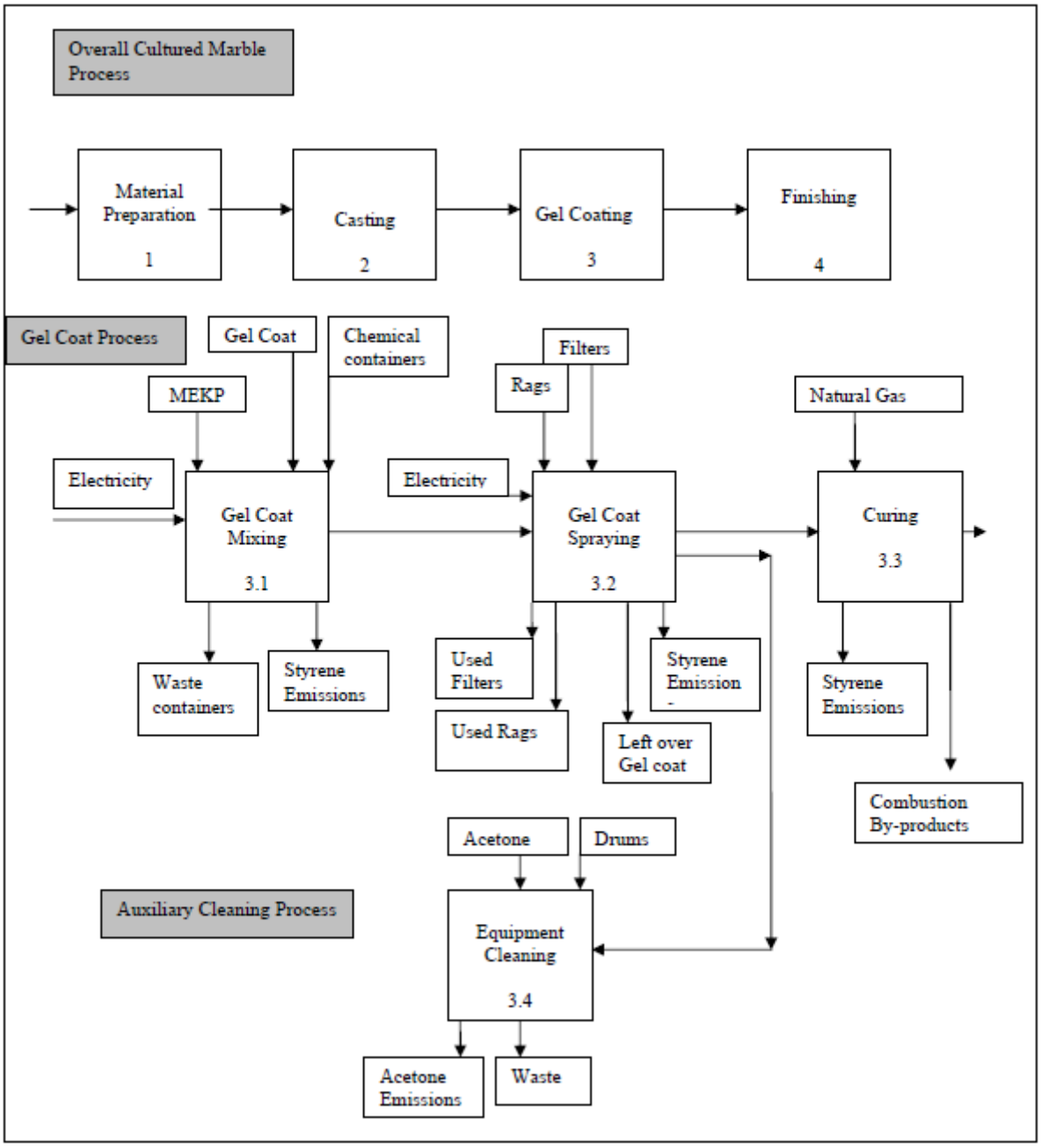
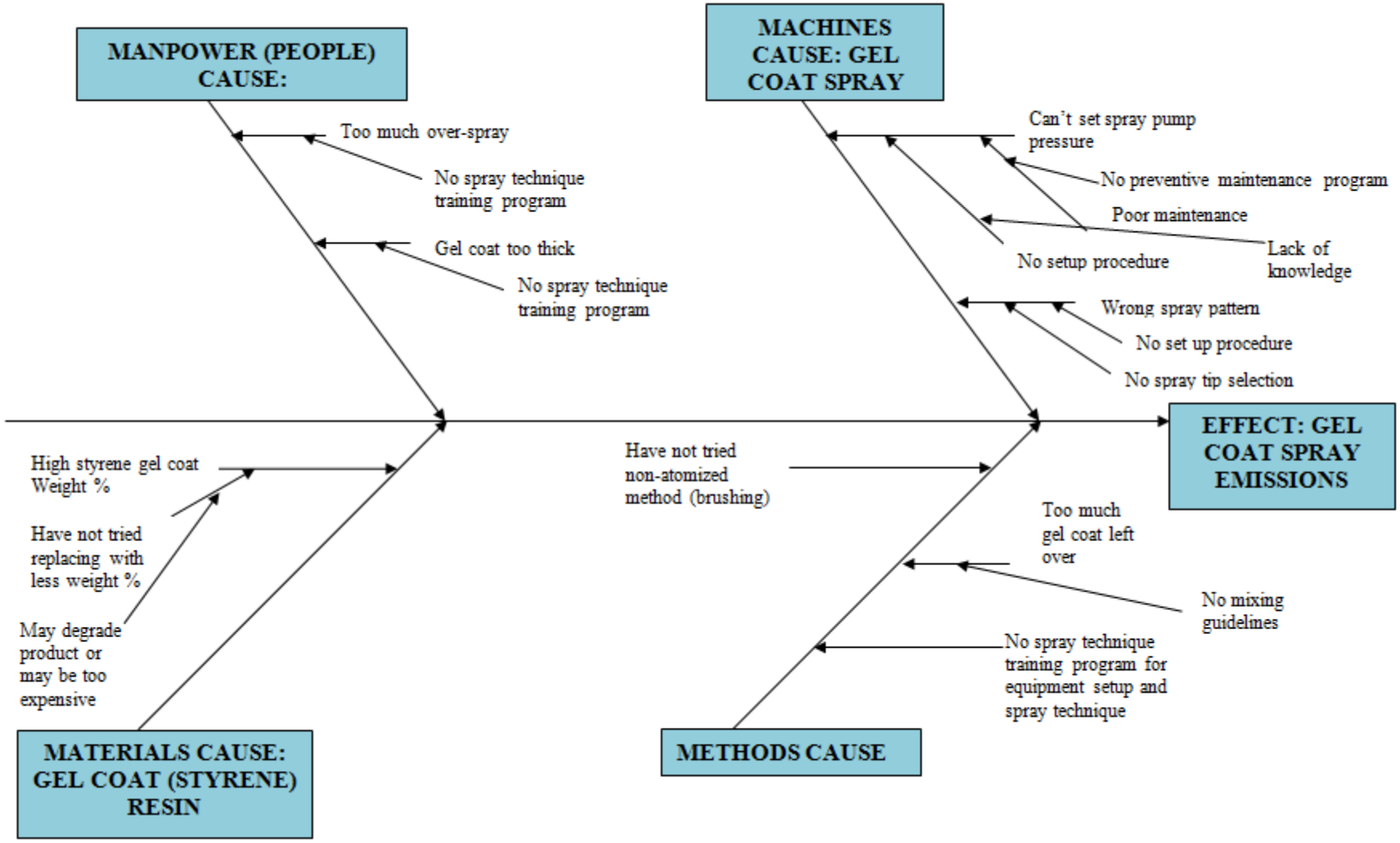


Figure 3: Example Causes of Gel Coat Emissions



Developing P2 Opportunities

After review of your process areas, researching root causes and reviewing process inputs and outputs, you are ready to begin discussing possible reduction opportunities with the P2 team.

A P2 opportunity is a way that you have thought to prevent pollution. Your review should have given you insight into how processes or employees are actually using materials and generating wastes and releases. Now you must be creative and look for ways to reduce chemical use, waste generation and releases in the areas you investigated. What you list here need only be potential opportunities. They do not all need to be implemented and, in fact, it may be best to list any idea that is considered.

After listing these potential opportunities you must determine if they will work for your facility. These are some questions to ask:

- Will it work technically? You may need to try it on a small scale first.
- Will it save your company money in a reasonable amount of time?
- Do you have the budget to get this done?
- Will it really help reduce toxicity, reduce potential employee health problems, reduce airborne releases, etc.?

Some successful ways to develop P2 opportunities include:

- Consulting with employees and get their ideas
- Using the waste management hierarchy (Refer to the Introduction- page 1)
- Consulting with chemical suppliers to see if they have substitutes
- Talking to other businesses to determine if they have already found a better alternative
- Using the internet to look for ideas and case studies
- Consulting vendors who may have developed new processes
- Reviewing Table 2 - Examples of P2 techniques in in Part 4 (page 52)
- Performing research at local libraries, universities or government clearinghouses
- Contacting ADEQ P2 staff for assistance

You will want to stay organized as you gather this information. One example of organizing your process area review results can be found Table 1 on page 31 for the "Gel Coat Spraying Process" example.

Refer also to Part 4 of this manual regarding P2 tools to help develop opportunities and share P2 analysis information with the P2 team.

Table 1: Organizing Analysis Results for Opportunities with information filled out for the "Gel Coat Spraying Process" identified in Figure 2

Process Area	Significant Inputs/Outputs	Environmental Aspects	Causes	P2 Opportunities (Alternatives)	Feasible to Implement?
1. Material Preparation					
2. Casting (Marble, Sinks)					
3. Gel Coat Process 3.1 (Mixing)					
3.2 Spraying	a. Gel coat (styrene) resin use/emissions	a. Air emission (styrene)	a. High styrene % gel coat, no spray training program	a.1 Reduce styrene emissions by using resin with less styrene a.2. Reduce styrene emissions by reducing the amount of over sprayed gel coat and train operators in proper spray techniques	a.1.No a.2. Yes
3.3 Curing					
3.4 Equipment cleaning					
4. Finishing					

Section 6 (Continued)

From the P2 opportunities developed by the P2 team's pollution prevention analysis, continue to answer the following questions in the Section 6 Plan forms. The opportunities listed below are based on Table 1 for the example "Gel Coat Spraying Process."

Opportunities

3. Are there pollution prevention opportunities?

Can the process "inputs" or method, etc. be eliminated or modified to reduce waste, emission(s) or toxic substance use?

☒ Yes ☐ No

Can any of the toxic or non-toxic substances be:

☐ Eliminated?	☐ Replaced with a less toxic substitute?
☒ Used less?	☐ Recycled or reused?
☐ Reformulated to reduce toxicity?	☐ None of these
	☐ Other _____

4. Based on the results from item 3 above: Describe the pollution prevention opportunities to eliminate at the source, reduce at the source, reduce toxicity, reduce the volume, reuse or recycle each waste emission or use of a toxic substance.

Opportunity (A): Train operators in the best available spraying techniques and spray equipment set up techniques to reduce overspray and styrene emissions.

Will this opportunity be developed into a goal?
☒ YES, fill out a goal sheet in Section 7, **Goal number** 1.

☐ NO, give the reason here

Opportunity (B): Replace current gel coat with a low styrene gel coat. This will reduce styrene emissions.

Will this opportunity be developed into a goal?
☐ YES, fill out a goal sheet in Section 7, **Goal number** ___.

☒ NO, give the reason here.

Explanation: Opportunity (B) will not be implemented at this time because low styrene gel coat is too expensive. We will continue to search for a more affordable product.

Write each feasible opportunity onto a goal sheet found in Section 7. Use one goal sheet for each feasible opportunity.

Section 7. P2 Performance Goal (A.R.S. §49-963.J.4.)

Facility Name: ABC Incorporated **P2 ID #: 200999**

Complete one form for each goal

1. Goal Statement: *Enter a specific performance goal or individual production process goal that includes a statement of the expected result. The goal statement should address what can be accomplished by implementing one of the opportunities from Section 6. Goal statements should be in the form (Action Verb) + (Target chemical, emission, or waste stream) used for/in (Process X). Use action verbs such as Reduce or Eliminate. For example: Reduce methylene chloride used for parts degreasing by 80%. If a goal cannot be measured or will take a long period of time to complete, then include an action plan that outlines measurable milestones. See page 48 of the guidance manual for an example of an action plan. Submit these goal sheets with your new plan or amendment and the annual progress report.*	2. Scheduled Completion Date (Month/Day/Year)	3. Completion Status: OS=On Schedule DR= Dropped D = Delayed C=Completed	4. Name of Toxic Substance and Waste stream ***Include CAS #; and RCRA Waste Code #***	5. State Volatile Organic Chemical "VOC", Ozone Depleting Chemical "ODC", "Both" or "NA"
Goal (# 1): Process Area(s) (#3) Goal Statement: Reduce styrene emissions from gel coat spraying by 35%	07/01/2015	☐ C ☒ OS ☐ D ☐ DR	**Styrene** **CAS# 100-42-5**	☒ VOC ☐ ODC ☐ ODC & VOC ☐ NA

6. If this goal has been delayed or dropped (box 3), provide an explanation and include a new estimated completion date:_____

7. Actions Needed to Implement the Goal:	8. Baseline Quantity (Starting amount)	9. Baseline Year	10. How much was reduced or eliminated?	11. Month & Year Box #10 Was Measured	12. How much money (US $) was saved by this goal?	13. Reduction Quantity is Adjusted for Production?	14. Production Ratio (Optional Unless Box #13 is Marked Yes)
Actions we will take to implement this goal are: Train operators in the best available spraying techniques and spray equipment set up technologies to reduce overspray and styrene emissions.	2500 (Check units) ☒ Pounds ☐ Gallons ☐ KWH ☐ Therms ☐ No measure	2012	____QTY. (Check units) ☐ Pounds ☐ Gallons ☐ KWH ☐ Therms ☐ No measure			☐ Yes ☐ No	

Guidance for Section 7:
Pollution Prevention Plan Goal Sheet

Copy and complete one P2 performance goal sheet in Section 7 for each Section 6 opportunity that will be implemented.

Complete the information on each goal sheet as follows:

1. Goal Statement
Enter the goal number. Each goal should have a unique number. Enter the number that you have assigned to the process area(s) that relate to this goal. Enter a statement of the expected result. The statement should address what can be accomplished by implementing one of the opportunities from Section 6.

Goal statements must be in the form of an Action Verb + Target chemical or waste stream used for/in Process by X%. Use action verbs such as "Reduce" or "Eliminate." For example: "*Reduce solvent used for degreasing by 80%."* If a goal cannot be measured or will take a long period of time to complete, then include an action plan (box 7) that outlines measurable milestones.

2. Scheduled Completion Date
List a realistic date (Month/Day/Year) for this goal's completion. All goals must have a specific date even if the project will be ongoing. For example: it could be the date that equipment is installed or the date recycling begins.

3. Completion Status
Report as on schedule as you intend to complete this goal. You will report updates on this goal on July 1st in a Progress Report. The forms will be e-mailed in April/May.

4. Name of Toxic Substance(s) or Waste Stream(s)
If possible, list **only one** chemical, chemical mixture or hazardous waste. Include a Chemical Abstracts Service (CAS) number or hazardous waste code. If the goal targets a group of chemicals and the baseline quantity is based on this chemical group, then put a group name, i.e. spent non-halogenated solvents. If the goal targets a chemical mixture, each chemical may be listed separately if each has a separate baseline. Please be as specific as possible.

5. Volatile Organic Compound (VOC) or Ozone Depleting Chemical (ODC)
If the toxic substance or waste stream is a VOC or ODC, or both, please indicate this by writing VOC, ODC or VOC/ODC as appropriate. If neither category applies, write N/A.

6. If this goal has been delayed or dropped (box 3), provide an explanation and include a new estimated completion date
Leave blank. You may report this information on July 1st in a Progress Report. The forms will be e-mailed in April/May.

7. Actions Needed to Implement the Goal
Write out the opportunity from Section 6 and describe the actions need to implement this goal.

8. Baseline Quantity
Provide a 12-month baseline quantity so that the goal can be measured. Check the appropriate units. ADEQ can accept units only in pounds, gallons, kilowatt hours (KWH), or therms. Give **only one** baseline per chemical or chemical group.

You can obtain this information from a variety of reports such as the Facility Annual Report, Toxic Release Inventory form, Tier II Chemical Inventory or purchasing records. If the goal is not measurable in pounds, gallons, kilowatt hours, or therms, such as when the goal is to develop P2 training, then check the box marked "Not Measured."

9. Baseline Year
Provide the year the baseline quantity was measured for. Use the latest year that information is available.

10. How much was reduced or eliminated?
Leave blank. You will report this information in a Progress Report. The forms will be e-mailed in April/May.

11. Month and Year Box #10 was measured
Leave blank. You will report this information in a Progress Report when the goal is completed. The forms will be sent to you via e-mail in April/May.

12. How much money (US $) was saved by this goal?
Leave blank. You will report this information in a Progress Report when the goal is completed. If you can quantify how much money was saved by the reduction/elimination provided in box 10, that information can be included in a future Progress Report. The forms will be sent to you via e-mail in April/May.

13. Reduction Amounts is Adjusted for Production?

Leave blank if doing a Plan. You will report this information in a Progress Report when the goal is completed. The forms will be e-mailed in April/May. For the annual progress at the time the goal is completed, you will determine the amount of waste, emissions, or toxic substance use that was actually prevented or reduced by this goal and place that number in this box.

14. Production Ratio (Optional Unless Box #12 is Marked "Yes")
Leave blank. You will report this information in a Progress Report when the goal is completed. The forms will be e-mailed in April/May.

Section 8. Management Practices and Procedures (A.R.S. §49–963.J.10)
Requirement: Describe provisions to incorporate pollution prevention into management practices and procedures in order to ensure its institutionalization.

Management has developed the following provisions to incorporate the Pollution Prevention Plan into established programs, policies and procedures in order to ensure its institutionalization:

(Check all that apply)

☒ The Management P2 Policy (Section 4) has been posted.
☒ Programs, procedures or policies were revised to incorporate Plan goals.

Management informs employees of procedural changes due to the Pollution Prevention Plan goals through various methods including:

- ☒ At mandatory monthly operation and safety meetings
- ☐ Internal memos, directives and information circulars
- ☒ Amendments to the operations manual
- ☐ Impromptu meetings held to discuss any immediate procedural, operational or equipment changes having to do with pollution prevention
- ☐ Other:_____

☒ All production managers will be responsible for assuring Plan activities are incorporated in procedures (where applicable).

☐ Pollution prevention is included in employee and manager performance evaluations.

☒ Employees are recognized or rewarded for suggesting successful pollution prevention opportunities.

☐ Accounting practices allocate the costs of waste management and regulatory compliance practices to the operations that use toxic chemicals or produce wastes or emissions.

☐ Pollution prevention considerations are included in procurement and inventory procedures to minimize the unnecessary purchase and accumulation of toxic substances.

☐ Other: _____

Guidelines for Section 8: Management Practices and Procedures

The Plan must include provisions to incorporate pollution prevention into established programs, policies, and procedures in order to ensure its institutionalization.

For consistency and convenience, a series of statements with check boxes have been provided for this section of the Plan. Check each box next to each statement that applies to your facility program. The management P2 policy from Section 4 must be made available to employees, so checking at least the first box and completing the first line is expected.

The box labeled "Other" (at the bottom of the page), is provided so you can easily include any additional practices or procedures. Please use additional pages as necessary to describe your provisions.

The list of items with check boxes are examples of practices used by facilities with highly successful pollution prevention programs. A discussion of some of these items are as follows:

☐ All production managers will be responsible for assuring Plan activities are incorporated in procedures.

Making production managers responsible gives them an incentive to ensure the process changes that have been laid out stay in effect.

☐ Pollution prevention is included in employee and manager performance evaluations.

This also gives people a stake in seeing that new P2 processes are successful.

☐ Employees are recognized or rewarded for suggesting successful pollution prevention opportunities.

P2 works best when ideas are solicited from everyone in the company. People that work with the processes, chemicals and wastes every day often have a different perspective on them than management. Rewards and recognitions help ensure that employees will continue to bring ideas to the P2/green team.

☐ Accounting practices allocate the costs of waste management and regulatory compliance to the operations that use toxic chemicals or produce wastes. Note: Some P2 accounting methods for new P2 projects can be found at this website: http://www.newmoa.org/prevention/topichub/subsection.cfm?hub=105&subsec=21&nav=21

Pollution prevention considerations are included in procurement and inventory procedures to minimize unnecessary purchase and accumulation of toxic substances.

☐ Pollution prevention considerations are included in procurement and inventory procedures to minimize the unnecessary purchase and accumulation of toxic substances.

The best way to avoid costly disposal of chemicals is not to bring them onsite in the first place. Purchasing and inventory controls can assure that unwanted and expired chemicals do not become a disposal problem.

Section 9: Employee Awareness and Training Programs (A.R.S. §49-963.J.9)
Requirement: The Plan shall include employee awareness training programs to involve employees in P2 planning and implementation to the maximum extent feasible.

Check either box 1 or 2. If you check box 2, you may check box 3 if a training sample is needed.

Training is completed and training documents are enclosed:

1. ☐ Our facility's P2 training documents are enclosed. We have also included evidence (such as Sign-in sheet) of how many employees were trained.

Training is not yet completed but a goal is established:

2. ☒ We will fill out the training goal sheet found on the following page, place it in the Plan and implement the goal to develop P2 training. We will send our P2 training documents to ADEQ after conducting training or in the next annual Toxic Data Report. We will also include evidence (such as sign-in sheet) of how many employees were trained.

3. ☒ ADEQ please send a copy of the example P2 training documents to assist in developing my training program.

(Check all that apply)

PURPOSE *(check at least the first box)*

☒ The purpose of the P2 employee training and awareness program is to teach employees about P2 so that they can participate in identifying opportunities and also assist in achieving the Plan goals.

☐ Additional Purpose:_____

OBJECTIVES *(check at least the first box)*

☒ The objectives of this program are to:

- Raise employee awareness of environmental related activities within the facility
- Train employees in their P2 responsibilities
- Recognize employees for their P2 efforts
- Encourage employee participation

☐ Additional Objectives: _____

SCOPE *(complete all questions)*

How frequently will training be held? Annually
What types of employees will attend? All employees
How will attendance be monitored? Sign in sheet

METHODS *(check at least one)*

The training methods will include:

☒ Class room training session(s) ☐ Video presentations
☐ Newsletters ☐ Posters ☐ Other: _____

TRAINING TOPICS *(check at least the first box)*

☒ The P2 training topics include the following subjects:

- Definitions related to P2
- Benefits of P2
- Waste management hierarchy
- Company pollution prevention plan
- How to submit P2 ideas

☐ Additional Topics: _____

Pollution Prevention Training Goal (A.R.S. §49–963.J.9.)

Facility Name: **ABC Incorporated** **P2 ID #: 200999**

Complete this form and include in Section 7 if no training documents are being sent to ADEQ-P2 at the current time.

1. Goal Statement: (For the training goal, fill in dates and goal number in Box 1. Submit this goal sheet with your plan, or amendment or your annual progress report (until goal is closed). Also, submit the training documents to ADEQ-P2 when completed with your annual progress report.	2. Scheduled Completion Date (Month/Day/Year)	3. Completion Status: OS=On Schedule DR= Dropped D = Delayed C=Completed	4. Name of Toxic Substance and Waste stream **Include CAS #; and RCRA Waste Code #**	5. State Volatile Organic Chemical "VOC", Ozone Depleting Chemical "ODC", "Both" or "NA"
Goal (# 2): Process Area(s) (# N/A) Develop a pollution prevention specific employee training program by 10/03/2013 (date). Send training documents that include evidence (such as sign in sheet) of how many employees were trained to ADEQ-P2 by 11/03/2013 (date).	11/03/2013	☐ C ☒ OS ☐ D ☐ DR	N/A	☐ VOC ☐ ODC ☐ ODC & VOC ☒ NA

6. If this goal has been delayed or dropped (box 3), provide an explanation and include a new estimated completion date: _____

_____

7. Actions Needed to Implement the Goal:	8. Baseline Quantity (Starting amount)	9. Baseline Year	10. How much was reduced or eliminated?	11. Month & Year Box #10 Was Measured	12. How much money (US $) was saved by this goal?	13. Reduction Quantity is Adjusted for Production?	14. Production Ratio (Optional Unless Box #13 is Marked Yes)
Actions we will take to implement the goal are: Training Program as discussed in Section 9 to include employee awareness and training programs to involve employees in pollution prevention planning and implementation to the maximum extent feasible. The number of people trained this year was:	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Guidance for Section 9:
Employee Awareness and Training Programs

This section of the Plan documents the requirement that the P2 Plan include employee awareness and training programs to involve employees in pollution prevention planning and implementation to the maximum extent feasible.

The P2 awareness and training program for this Plan must specifically cover pollution prevention topics - not hazardous waste handling, Occupational Safety and Health Administration (OSHA) training, stormwater, etc.

The P2 policy statement in Section 4 can contain a statement about the commitment to employee involvement in P2.

Complete the information in this Section 9 as follows to assure compliance with the statutes.

Training Implementation and Training Documents:
Check either box 1 or box 2. If you check box 1, submit the facility's P2 training documents along with the P2 Plan. If you check box 2, complete the training goal sheet provided and include the completed sheet in your Plan submittal. Completing this training goal and submitting the resulting documents to ADEQ-P2 is a requirement if training documents are not provided at this time.

Training Assistance:
Check this box to have ADEQ send sample training documents that can be used as a foundation to develop facility specific training. Sample P2 training is available in Spanish and English for download on our website at http://www.azdeq.gov/environ/waste/p2/tools.html under "P2 Presentations." If you need PowerPoint versions of the slides, e-mail a P2 staff member using the contact information in the Introduction on page 1.

Purpose:
Check at least the first box. Please write in any additional purpose for the training.

Objectives:
Check at least the first box. Please write in any additional objectives for this training.

Scope:
Write a brief response to all three questions detailing the logistics of the training.

Methods:
Check at least one box. Please write in any additional training methods that will be used.

Topics:
Check at least the first box. The training documents provided must include these topics. Please write in any additional topics that will be discussed.

Section 10. Existing Pollution Prevention Activities (A.R.S. §49-963.J.8)
Requirement: Provide an analysis of pollution prevention activities that all are already in place that are consistent with the Pollution Prevention Plan requirements.

Check ONE of the boxes below.

☐ We have not documented any previous P2 activities at our company.

OR

☒ We have documented P2 activities at our company and have described them below or attached addition pages with information about these projects with this Plan. (Include as much specific information as possible and any available quantitative data without disclosing any confidential business information.)

Describe or list the P2 activities that are already in place including amounts reduced (if available):

1). In 2012 this facility conducted a Green Lights electricity usage review. At that time all fluorescent light ballasts were replaced with electronic ballasts and more efficient light bulbs (Model T-8) have been used since. This has saved the facility about 15% on its electric bill.

Guidance for Section 10:
Existing Pollution Prevention Activities

This section provides an opportunity for your facility to highlight any pollution prevention activities that have taken place prior to submittal of the Pollution Prevention Plan. **Please only include those activities completed prior to the starting date of this Plan.**

Check one of the boxes provided. We encourage you to provide as much detail about any past pollution prevention efforts. This is a chance to show your facility's past commitment to pollution prevention and its results.

Note: You do not need to complete this section if you are writing an amendment and you previously completed this section in the original Plan.

Example Plan Checklist

Instructions: Please include the completed checklist below with the Plan forms.

☒ Completed and submitted Section 1 for the primary facility.

☒ Completed and submitted Section 2 with official signature.

☒ Completed and submitted Section 3 for each facility included in this Plan.

☒ Completed and submitted Section 4, Pollution Prevention (P2) Policy, provided in the guidance manual, or developed your own policy with the required items: management and corporate support for the P2 Plan, and a commitment to implement the Plan to achieve the Plan goals.

☒ Completed and submitted Section 5 identifying the scope and objectives, with a Plan time frame of at least two years.

☒ Completed and submitted a Section 6 analysis for all process areas, each Toxic Release Inventory (TRI) toxic chemical that met the Plan filing thresholds and all hazardous or acutely hazardous wastes generated if the facility met the cumulative hazardous waste thresholds.

☒ Reviewed all process areas and waste streams described in Section 6 for possible pollution prevention opportunities.

☒ Completed and submitted Section 7 (Plan goals) for each feasible opportunity identified in Section 6.

☒ Completed and submitted Section 8 (Management Practices) describing how management will incorporate pollution prevention into activities and ensure it is institutionalization.

☒ Completed and submitted Section 9 (Employee Training) outlining the pollution prevention program to occur at your facility, and either completed a training goal or submitted a copy of the facility's pollution prevention training program documents. *Note: Pollution prevention training documents must, as a minimum, include a definition of pollution prevention, a description of the waste management hierarchy, the benefits of pollution prevention and information on how the employees can become involved in pollution prevention planning and implementation. Please also include* evidence (such as sign in sheet) of how many employees were trained in P2.

☒ Completed and submitted Section 10 (Existing Pollution Prevention Activities) documenting past pollution prevention activities (Not required for an amendment).

Part 3

- **Staying in Compliance By Maintaining your Plan**
- **Instructions for Completing a Plan Amendment**

Staying in Compliance By Maintaining your Plan

Pursuant to A.R.S. §49–963.G, a facility must maintain and implement the Plan until the facility ceases operation or no longer meets any one of the quantitative Plan threshold filing requirements listed in A.R.S. §49–962 and §49–963.

Maintaining and implementing the Plan includes the implementation of the Plan to meet the Plan goals, tracking the status of the Plan goals and providing explanations if the goals are not met in the annual Toxic Data Report (TDR) due on July 1. The TDR includes:

- A P2 Plan Annual Progress Report on completion of the specific reduction goals which includes:
    - Completion status (on schedule; closed; delayed; dropped)
    - How much reduction was achieved

  Annual progress report instructions are downloadable at:
  http://www.azdeq.gov/function/forms/appswaste.html#p2

- An Annual Toxic Chemical Release Inventory (TRI) Report *
    - U.S. EPA: Toxic Chemical Release Inventory (TRI) Form A or Form R

  *Note: ADEQ will automatically receive a copy of your TRI forms if you submit the forms to the U.S. EPA using the TRI-ME web software. In that case a hard copy submittal to ADEQ is not required. Hard copies of trade secret TRI forms should be submitted to the same address for the TDR and P2 Plan submittal:
  Arizona Department of Environmental Quality
  WPD Sustainability Programs Unit
  Pollution Prevention Program – 5th Floor
  1110 West Washington Street
  Phoenix, Arizona 85007

- Any needed P2 Plan Amendments. If the facility Plan time frame has ended prior to submittal of the yearly TDR and the facility still meets one of the Plan filing thresholds to maintain a Plan, a *Plan Amendment* must be submitted by July 1. (The Plan time frame can be found on the cover page and in Section 5 of your approved Plan). The Plan Amendment can include analyses of new areas of the facility, including new process reviews, root cause analyses, and new goals. A Plan Amendment is required to:
    - To make changes to an existing P2 Plan
    - To extend the time frame of an existing Plan
    - To add new goals or amend existing goals

Failure to maintain the Plan constitutes noncompliance with A.R.S. §49–963 and will result in it being inadequate and deficient. This may lead to enforcement action.

Instructions for Completing a Plan Amendment

You need to file an Amendment to your Plan whenever:

1) The Plan's time frame has expired. In other words, the Plan's ending time frame in Section 5 has been reached.

2) The Plan has not expired, but you need to make changes to the Plan.

1) The Plan's time frame has expired.
An Amendment is required to continue the Plan and keep it active when the Plan time frame has expired. The Amendment is due no later than July 1 after the expiration date or within 6 months of the expiration date (whichever is less). The purpose of the Amendment is to update the P2 Plan with current information. The Amendment uses the same forms and instructions as a new Plan, but Plan sections that do not change are not required to be submitted again. In most amendment submittals it is not necessary to repeat information if it is found in the original Plan or previous Amendment. For each Amendment the following sections should be completed and submitted.

- The Plan checklist
- A signed certification statement and any updates to the facility information in Section 1
- Any updates to the Plan Section 3 facility information.
- Any change to the policy statement or information in Section 4
- Updates to Section 5 including the plan scope or objectives for new process areas to be analyzed in Section 6.
- Updates to add new process areas, and process analyses and P2 opportunities not previously provided in Section 6.
- Any new pollution prevention goal sheets in Section 7
- Revisions to previous information about toxic substances and hazardous wastes which were not discussed in the original Plan or subsequent Amendments

For Example: If you file a Toxic Release Inventory (TRI) form for chlorine and this toxic substance was not addressed or analyzed in your original Plan, then you need to complete Section 6 for this chemical. If feasible opportunities can be developed for the TRI chemical corresponding goal sheets should be included in Section 7.
Note: When adding new goals, the goal number should be sequential with the original Plan goals. For example, if the last goal was goal # 5, then the first new goal should be goal #6.

2a) The Plan has not expired but a goal's time frame is delayed past the end of the Plan's end date.

Goals listed in the existing Plan, which have been delayed past the end of the Plan time frame due to scheduling or budgeting constraints, can be extended by updating the scheduled completion date (box 2) on the Progress Report goal sheet. An explanation (reason for) for the delay should be provided on line 6 or on the page bottom margin. If additional space is required, additional page should be attached with the explanation and an action plan.

For Example:

Goal Sheet line 6: Add an explanation why the goal was delayed
Goal sheet box 7: Add the action plan or include it on a separate sheet.

Action Plan Example: Goal 3. Reduce the use of water by 50% in process area #3, electroplating rinses.

Action Plan

Step 1:	Investigate the use of air actuated solenoid valves to control the volume of the rinse water: Install valves, floats, and evaluate results. Completion date: completed
Step 2:	Investigate point source water treatment at each rinse tank: Request meetings with suppliers solicit proposals and obtain quotations. Completion date: 3/31/2012
Step 3:	Test point source treatment: Select one rinse tank set, purchase or lease one series of columns, install, and evaluate results. Completion date: 6/30/2012
Step 4:	Test the feasibility of recirculating the rinse water: Re-pipe one tank set, recirculate rinse water, and evaluate results. Completion date: 8/31/2012
Step 5:	Expand test to include all available tank sets: Review price (cost), expand piping system, decide on recirculating or direct to a sewer, install, and evaluate results. Completion date: 11/30/2012

2b) The Plan has not expired but you need to change something in the Plan.

An Amendment should be submitted if one or more Sections of the original Plan need to be changed or updated and the Plan has not expired. Mark the changes so that ADEQ-P2 staff can clearly understand which part has changed and how the Plan should now read. Please submit the entire page or Section to replace the outdated one. It is not necessary to resubmit the entire Plan to change a Section.

Some companies, during the year identify, new opportunities and establish new goals for P2 and want to incorporate these into the existing Plan. If this is the case, complete a new certification section (Section 1), new analysis and opportunities section (Section 6) and performance goal sheets for each goal (Section 7), amendment cover sheet, and amendment checklist according to previous amendment discussion described in this guidance manual.

How Do I Write an Amendment?

- Writing an Amendment is similar to writing a Plan. You can utilize this guidance manual for assistance on writing an Amendment. Please note that the goals for an Amendment must follow the chronological order of goals that have already been defined in a Plan. For example, if the original plan had 10 goals any new goals added to the Amendment will be

numbered starting with goal # 11, even if a prior goal was dropped or completed.

- Gather a multi-functional team/green team of employees to develop the Amendment.
- Set the scope and objectives to guide you through the rest of the process.
- Complete a review of current waste and emission generation and the manufacturing, processing or use of toxic substances.
- Develop a system to collect and track the necessary information.
- Develop P2 opportunities and goals.
- Complete the P2 forms and mail them to the ADEQ-P2 Program.

What Should Be Addressed in a Pollution Prevention Amendment?

An Amendment should address all toxic substances and wastes for which the facility meets thresholds, which were not addressed in the original Plan. Address all toxic substances that the facility uses in excess of 10,000 pounds, all toxic substances for which the facility filed a Toxic Release Inventory Form, and all hazardous wastes generated if the facility meets the hazardous waste thresholds.

If a facility has many processes, it may not be possible to complete Section 6 (Analysis and Opportunity Identification) or Section 7 (P2 Performance Goals) for each waste or toxic substance in a Plan or Amendment submittal. ADEQ recognizes that only so many projects can be taken on at once depending on the facility size, available resources, and strength of commitment. However, the Opportunities Section needs to be completed for each process area addressed. If no reduction opportunities are discovered, the Plan must state that fact. If opportunities are discovered, but not feasible at present, the Plan should state that fact. These non-implemented opportunities may become goals in future Amendments to the Plan as they become feasible.

Part 4

- **Where to find Information for your Plan**
- **Tools to Assist with Root Cause Analysis**

Where to find Information for your Plan

Regulatory Information:

- Waste shipment manifests
- Emission inventories
- Biennial hazardous waste reports
- Waste, wastewater, and air emissions analyses, including intermediate streams
- Environmental audit reports
- Permits and/or permit applications
- Superfund Amendments and Reauthorization Act (SARA) Title III reports

Raw Material/ Production Information

- Production composition and batch sheets
- Material application diagrams
- Material safety data sheets
- Product and raw material inventory records
- Operator data logs
- Operating procedures
- Production schedules

Process Information:

- Process flow diagrams
- Design and actual material and heat balances for production processes, and pollution control processes
- Operating manuals and process descriptions
- Equipment lists
- Equipment specifications and data sheets
- Piping and instrument diagrams
- Plot and elevation plans
- Equipment layouts and logistics

Accounting Information:

- Waste handling, treatment, and disposal costs
- Water and sewer costs, including surcharges
- Costs for non-hazardous waste disposal, such as trash and scrap metal
- Product, energy, and raw material costs
- Operating and maintenance costs
- Cost accounting reports

Other Information:

- Environmental policy statement
- Standard procedures
- Organization charts

Table 2 – Examples of P2 techniques

METHOD	AREAS	TECHNIQUES
Source Reduction	Good Operating Practices	• Improve maintenance scheduling, record keeping or procedures • Change production schedules to minimize equipment and feedstock changeovers
	Inventory Control	• Institute procedures to ensure that materials do not stay in inventory beyond shelf lie • Eliminate shelf-life requirements for stable materials • Institute better labeling procedures • Institute a clearinghouse to exchange materials that would otherwise be dates • Practice “first in” and ‘first out” when using materials
	Spill and Leak Prevention	• Improve storage or stacking procedures • Improve procedures for loading, unloading, and transfer operations • Install overflow alarms or automatic shutoff valves • Install vapor recovery systems • Implement an inspection or monitoring program for potential spill or leak sources
	Surface Preparation and Cleaning	• Modify spray systems or equipment • Substitute coating materials used • Improve application techniques
	Product Modifications	• Change product specifications • Modify design or composition of product • Modify packaging
	Raw Material Modification	• Increase purity of raw materials • Substitute less toxic raw materials
	Process Modification	• Institute recirculation within a process • Modify equipment, layout or piping • Use a different process catalyst • Institute better controls on bulk containers to minimize discarding empty containers • Change from small to bulk containers
	Cleaning and Degreasing	• Modify stripping/cleaning equipment • Change to aqueous cleaners • Improve draining procedures • Redesign part racks to reduce drag out • Improve rinse equipment operation

Tools to Assist with Root Cause Analysis

There are many analysis methods in use by pollution prevention practitioners. Some of these methods include:

- Process mapping
- Pareto charts
- Cause and effect diagrams
- Weighted sum method
- Five Whys (or more)

Process mapping is often used first to develop the environmental aspects of your processes. Environmental aspects are elements of your company's activities, products, or services that can interact with the environment.

Next, cause and effect diagrams can be used to search for the root causes of each particular aspect. The Five Whys questioning technique is also used alone or used with the cause and effect analysis, to help develop root causes. Companies have other analysis techniques that may also be useful for this work. These analysis methods historically came from the area of continual quality improvement and are discussed in various books and in articles on the internet. Some of these methods are discussed below.

Process Mapping

Use the process map tool for analyzing processes and developing a list of environmental aspects. Process mapping allows you to break any process down into individual events or activities and to display these in shorthand form showing the logical relationships between them.

Constructing a process map promotes better understanding of processes, and better understanding of processes is a pre-requisite for improvement. The work steps on your map show how materials flow through your process to result in a product. A process map gives you a valuable tool to track material use and loss. It can also be used to track energy and water use.

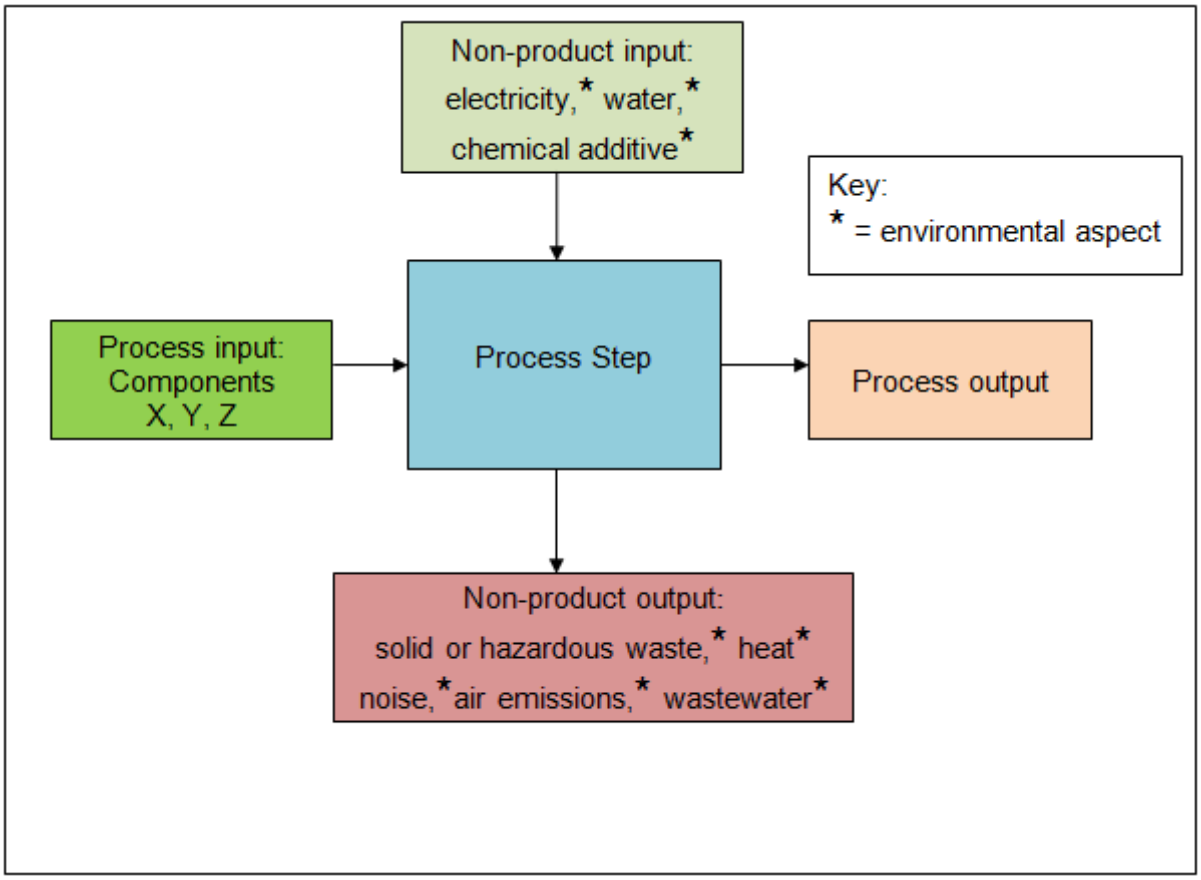
Unlike flowcharts or equipment schematics which use a complex system of symbols, a process map uses simple boxes and arrows (refer to Figure 4). Boxes denote work steps and arrows denote the movement of material and waste. Arrows pointing left and right represent the movement of product. Arrows pointing down into a box represent material inputs to that step. Arrows pointing down (out of a box) represent waste, emissions or pollution created by that step.

Step 1: Understanding the Basic Process Mapping Tool

There are two basic components to process mapping:
1) Developing a process map
2) Analyzing each unit operation

1. Developing a process map or breaking a process down into unit operations
The first basic task in process mapping is to break down a process into its component steps or unit operations. The process map depicts these steps and the relationship between them.

Figure 4- Process Map Configuration



Source USEPA http://www.epa.gov/dfe/pubs/iems/tools/process.pdf

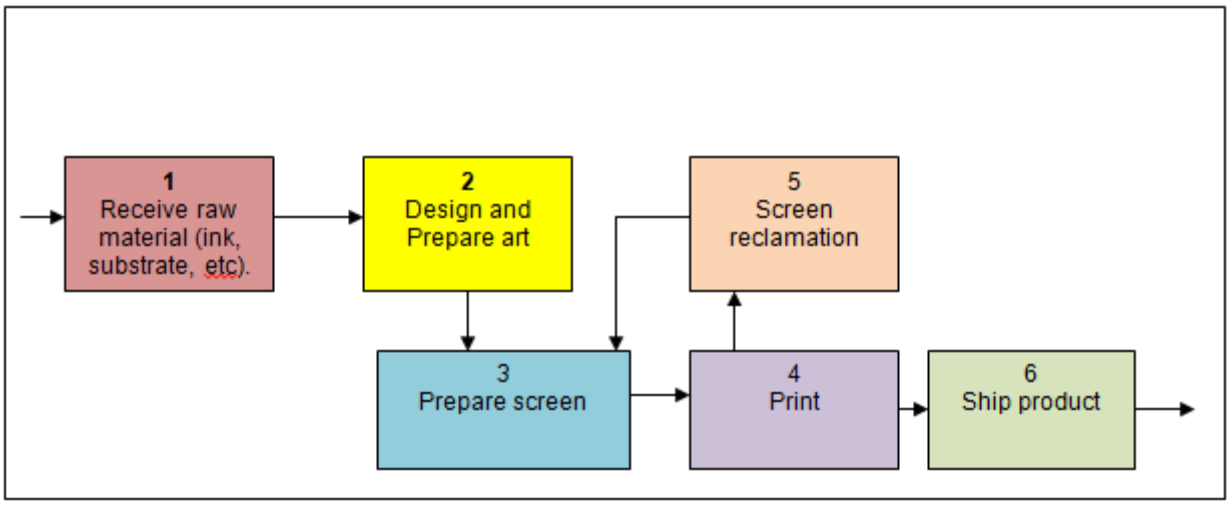
Figure 5 shows the basic processes carried out in a screen printing shop. Of course, many of these processes have separate steps to them. These steps are called unit operations.

2. Analyzing each unit operation

The second basic task in process mapping is to analyze each unit operation in the form of a diagram that answers the following questions:

- What is the *product input* to each unit operation? (The product input to a given unit operation is generally the product output of the preceding unit operation. For the first unit operation of a process, there may not be any "product input.")
- What are the *non-product inputs* to the unit operation? (These include raw materials and components as well as energy, water, and other resource inputs.)
- What is the *product output* of the unit operation?
- What are the *non-product outputs* of the unit operation? (These include solid waste, water discharge, air emissions, noise, etc.)
- What are the *environmental aspects* of the unit operation? (These may have been designated as inputs or outputs.)

Figure 5 – Process Map for a Screen Printing Shop



Pareto Chart

Information gathered in the process-mapping phase of the P2 analysis can be used to select process areas on which to focus to help problem solving and decision-making. This is generally more useful than relying solely on a walk-through or other P2 assessment method. However, a walk-through using process maps is essential to the proper verification of the information in the maps.

Each organization has its own means for selecting P2 opportunities. However, the Pareto chart is a tool that can be used to help the P2 team through this process selection.

The Pareto principle is the principle that 20 percent of the sources cause 80 percent of the problems, or 20 percent of the P2 opportunities provide about 80 percent of the cost benefits.

A Pareto Chart is a vertical bar graph showing problems in a prioritized order, so it can be determined which problems should be tackled first. It is a bar chart that displays the relative frequency of problems in a process or operation. The chart is used to determine priorities for which process areas or activities to look at for the P2 Plan. In the chart each bar represents the relative frequency of a problem.

If the data is available, you can apply Pareto's rule, and complete a Pareto chart, whenever a choice has to be made between a number of alternative directions for action. This may be after an analytical exercise has been completed to uncover the possible sources of a particular problem, or after a brainstorming session to generate creative ideas to address an issue. The highest ranked effect may provide the starting point for a cause and effect (CE) diagram.

Cause and Effect Diagram

A Cause-and-Effect (CE) Diagram is a tool that is useful for identifying sorting, displaying and organizing the known or possible causes of a problem or effect. The structure provided by the diagram helps team members think in a very systematic way. Some of the benefits of constructing a CE Diagram are that it:

- Helps determine the *root causes* of a problem or quality characteristic using a structured approach
- Encourages group participation and utilizes group knowledge of the process
- Uses an orderly, easy-to-read format to diagram cause-and-effect relationships
- Indicates possible causes of variation in a process
- Increases knowledge of the process by helping everyone to learn more about the factors at work and how they relate
- Identifies areas where data should be collected for further study

With a CE Diagram, the user can see all possible causes for a particular effect, and hopefully find the root causes.

This type of diagram is sometimes called an "Ishikawa" diagram because it was invented by Professor Kaoru Ishikawa of Tokyo University, a highly regarded Japanese expert in quality management. It is also called a "fishbone" diagram because of the way it looks.

The major purpose of the CE Diagram is to act as a first step in problem solving by generating a comprehensive list of possible causes. It can lead to immediate identification of major causes and point to the potential remedial actions or, failing this, it may indicate the best potential areas for further exploration and analysis.

At a minimum, preparing a CE Diagram will lead to greater understanding of the problem. It is an effective tool that allows people to easily see the relationship between factors to study processes, situations, and for planning. Like regular brainstorming this is best done with a team but one is not required.

You can construct a CE Diagram whenever you need to investigate the causes or contributing factors for an effect (be it a quality characteristic or other outcome) which is of concern to you. This will most likely be after you have conducted a general investigation of problems for a particular function, product, or service, and ranked them using a Pareto Chart.

When should a team use a CE Diagram?

Constructing a CE Diagram can help your team when you need to:

- Identify the possible root causes, the basic reasons, for a specific effect, problem, or condition

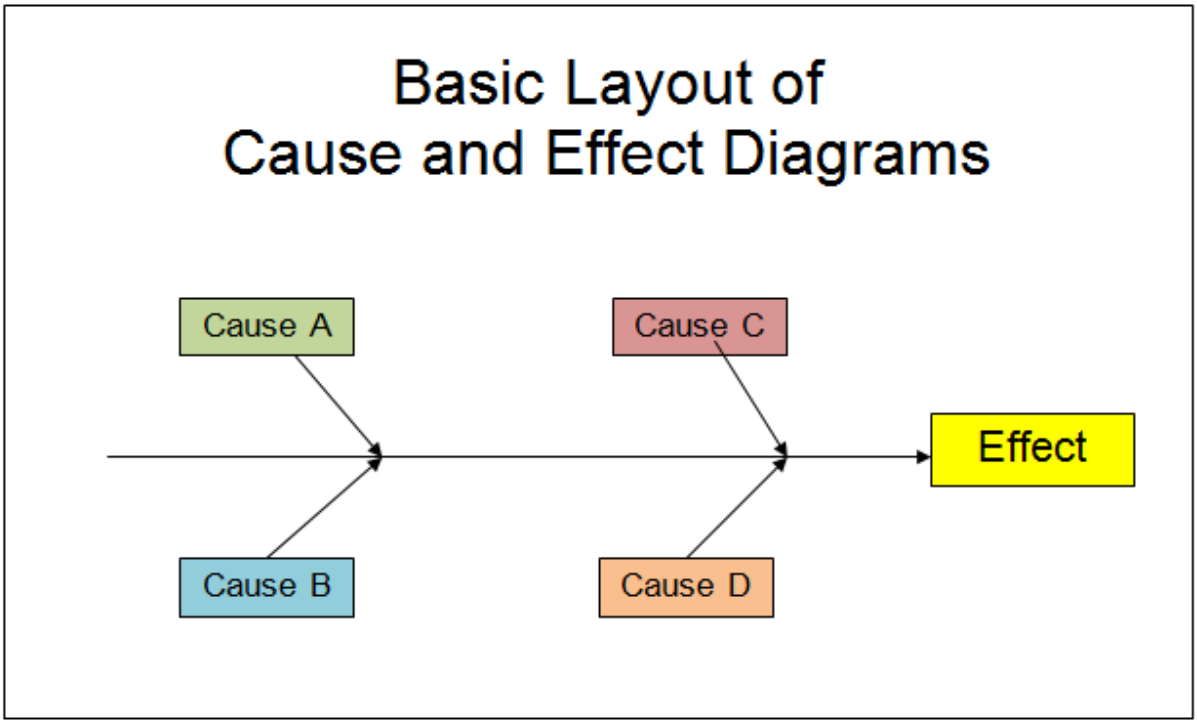
- Sort out and relate some of the interactions among the factors affecting a particular process or effect

● Analyze existing problems so that corrective action can be taken

How to develop a CE Diagram?

When you develop a CE Diagram, you are constructing a structured, pictorial display of a list of causes organized to show their relationship to a specific effect. Figure 6 shows the basic layout of a CE Diagram. Note that the diagram has a cause side and an effect side.

Figure 6- Basic Layout of Cause and Effect Diagrams



Step 1 - Identify and clearly define the outcome or EFFECT to be analyzed

- Decide on the effect to be examined. Effects are stated as particular quality characteristics, problems resulting from work, planning objectives, and the like.
- Use operational definitions. Develop an operational definition of the effect to ensure that it is clearly understood.
- Remember, an effect may be positive (an objective) or negative (a problem), depending upon the issue that's being discussed.
- Using a positive effect which focuses on a desired outcome tends to foster pride and ownership over productive areas. This may lead to an upbeat atmosphere that encourages group participation. When possible phrase the effect in positive terms.
- Focusing on a negative effect can sidetrack the team into justifying why the problem occurred. However, it is sometimes easier for a team to focus on what causes a problem than what causes an excellent outcome. While you should be cautious about the fallout that can result from focusing on a negative effect, getting a team to concentrate on things that can go wrong may foster a more relaxed atmosphere and sometimes enhances group participation.

You must decide which approach will work best with your group.

Step 2 - Draw the SPINE and create the EFFECT box.

- Draw a horizontal arrow pointing to the right. This is the spine.
- To the right of the arrow, write a brief description of the effect or outcome which results from the process.

  Example**:** The **EFFECT** is *Poor Gas Mileage*

Step 3 - Identify the main CAUSES contributing to the effect being studied. The main causes are the labels for the major branches of your diagram and become categories under which to list the many causes related to those categories.

- Establish the main causes, or categories, under which other possible causes will be listed. You should use category labels that make sense for the diagram you are creating. Here are some commonly used categories:

  - 3Ms and P - methods, materials, machinery, and people
  - 4Ps - policies, procedures, people, and plant
  - Environment - a potentially significant fifth category

- Write the main causes (categories) your team has selected to the left of the effect box, some above the spine and some below it.
- Draw a box around each category label and use a diagonal line to form a branch connecting the box to the spine.

Step 4 - For each major branch, identify other specific factors which may be the CAUSES of the EFFECT.

- Identify as many causes or factors as possible and attach them as sub-branches of the major branches.

Example**:** The possible **CAUSES** for *Poor Gas Mileage* are shown in Figure 7.

- Fill in detail for each cause. If a minor cause applies to more than one major cause, list it under both.

Step 5 - Identify increasingly more detailed levels of causes and continue organizing them under related causes or categories. You can do this by asking a series of *why* questions.

Example: We'll use a series of *why* questions (remember the "Five WHYs") to fill in the detailed levels for one of the causes listed under each of the main categories.

Q: Why was the driver USING THE WRONG GEAR?
A: The driver *couldn't hear the engine*.
Q: Why couldn't the driver *hear the engine*?
A: The radio was too loud.

Q: Why were the TIRES UNDERINFLATED?
A: *No record of tire pressure*
A: *Difficult air stems*
Q: Why were the *air stems difficult*?
A: Poor design

Q: Why was MAINTENANCE POOR?
A: *Lack of money*
A: *No awareness*
Q: Why was WRONG OCTANE GAS used?
A: *Didn't know recommended octane*
Q: Why wasn't *recommended octane* known?
A: No owner's manual

Figure 7 shows how the diagram looks when all the contributing causes that were identified by the series of *why questions* have been filled in. As you can see, there may be many levels of causes contributing to the effect.

NOTE: You may need to break your diagram into smaller diagrams if one branch has too many sub-branches. Any main *cause* (3Ms and P, 4Ps, or a category you have named) can be reworded into an *effect*.

Step 6 - Analyze the diagram. Analysis helps you identify causes that warrant further investigation. Since Cause-and-Effect Diagrams identify only possible causes, you may want to use a Pareto Chart (histogram) to graphically rank the possible from most frequent to least frequent to help your team determine the cause to focus on first. *Going after an "easy" yet infrequent or insignificant cause will probably not reap benefits.*

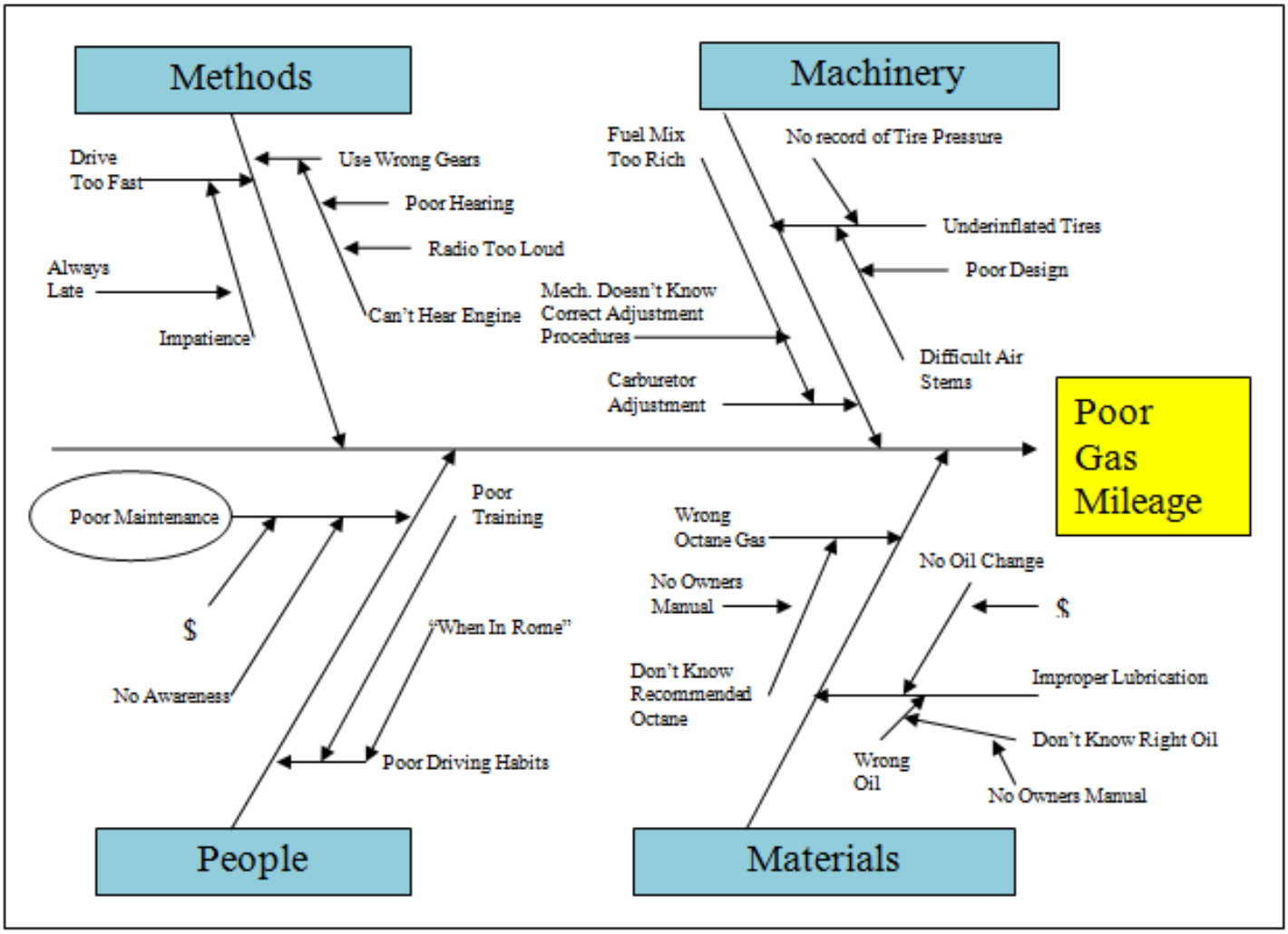
- Look at the balance of your diagram, checking for comparable levels of detail for most of the categories.
    - A thick cluster of items in one area may indicate a need for further study.
    - A main category having only a few specific causes may indicate a need for further identification of causes.
    - If several major branches have only a few sub-branches, you may need to combine them under a single category.
- Look for causes that appear repeatedly. These *may* represent root causes.
- Look for what you can measure in each cause so you can quantify the effects of any changes you make.
- Most importantly, identify and circle the causes that *you can take action on.*

EXAMPLE: Let's analyze the diagram we have been constructing.

- The level of detail is pretty well balanced.
- No causes are repeated.

- *Poor Maintenance* appears to be a cause for which you could develop measurements
- Moreover, *Poor Maintenance* appears to be a cause that you can take action on. It is circled in Figure 7 to mark it for further investigation.

Figure 7 – Example Cause and Effect Diagram for Poor Gas Mileage



Weighted Sum Method

There are many different methods to determine which items are the most significant pollution prevention opportunities. One method was discussed previously was the Pareto Chart. Another method is the weighted sum method. The Weighted Sum Method is a quantitative method for screening and ranking pollution prevention opportunities. This method allows you to rank pollution prevention opportunities based on the criteria important to your facility. This method involves three steps:

1. Determine what criteria are important for your facility's goals and constraints.

   For example, the following criteria could be used:

   - Reduction in waste quantity

- Reduction in waste treatment or disposal costs
- Reduction in raw material cost
- Product quality not affected
- Low operating and maintenance costs

Assign a weight to each criterion. Use a scale from 0 to 10 to rate their importance (0 for low and 10 for high).

2. Each opportunity is rated for each criterion selected. Again, a scale of 0 to 10 could be used.
3. Finally, the rating of each opportunity is multiplied by the ranking of each criterion. The opportunities' overall rating is the weighed sum of the products.

The opportunities with the best overall rating are then analyzed for technical and economic feasibility. The following example illustrates the Weighted Sum Method for screening and ranking opportunities:

ABC Corporation has determined that reduction in waste treatment costs is the most important criterion, with a weight factor of 10. Other significant criteria include reduction in safety hazards (weight of 8), reduction in liability (weight of 7), and ease of implementation (weight of 5). Options X, Y and Z are then each assigned effectiveness factors. For example, option X is expected to reduce waste by nearly 80%, and is given a rating of 8. It is given a rating of 6 for reducing safety hazards, 4 for reducing liability, and 2 for ease of implementation. The table below shows how the options are rated overall, with effectiveness factors also estimated for options Y and Z.

		Ratings for each option		
Rating Criteria	Weight	X	Y	Z
Reduce treatment costs	10	8	6	3
Reduce safety hazards	8	6	3	8
Reduce liability	7	4	4	5
Ease of implementation	5	2	2	8
Sum of weight times ratings		**166**	**122**	**169**

From this screening, option Z rates the highest with a score of 169. Option X's score is 166 and Y's score is 122. In this case, both option Z and X should be selected for further evaluation because both their scores are high.

The Five Whys: A Root Cause Analysis Technique

A good technique to help determine the root cause is to continuously ask ***why*?** By repeatedly asking the question ***why*** (five times is a good rule of thumb), you can peel away the layers of symptoms which can lead to the root cause of a problem. You do not need to stop at 5.

Very often the apparent reason for a problem will lead you to another question. For a facility using a waste solvent as example:

Why is the solvent a waste? *Because it is contaminated with oil.*

Why is it contaminated with oil*? Because the solvent was used to clean oil off of parts.*

Why are the parts oily? *Because the manufacturer puts a coating of oil on them before shipping them to this facility.*

Why does the manufacturer put a coating on them*? To prevent the parts from corroding after manufacture.*

Why is this type of corrosion protection absolutely necessary? *There is no other way to protect the parts from corrosion.*

The root cause of this solvent waste is corrosion protection. If we investigate this root cause in this manner, we may find that solvent may not even be necessary if the oil is not needed (source reduction). If the oil is absolutely necessary, then we look at the hierarchy for answers to investigate maybe a less toxic solvent or water based system can be used (source reduction) , if not, can we recycle the solvent to use less? In other words, the root cause would lead to more questions from the waste management hierarchy. Can the amount of oil be less? Can the solvent be recycled? Can a less toxic substance be used to remove the grease?

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